

Humanoid Flight Metabolic Simulator Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)



ABSTRACT

NASA's Evolvable Mars Campaign (EMC) has identified several areas of technology that will require significant improvements in terms of performance, capacity, and efficiency, in order to make a manned mission to Mars possible. These include crew vehicle Environmental Control and Life Support System (ECLSS), EVA suit Portable Life Support System (PLSS) and Information Systems, autonomous environmental monitoring, radiation exposure monitoring and protection, and vehicle thermal control systems (TCS). (MADMACS) in a Suit can be configured to simulate human metabolism, consuming crew resources (oxygen) in the process. In addition to providing support for testing Life Support on unmanned flights, MADMACS will also support testing of suit thermal controls, and monitor radiation exposure, body zone temperatures, moisture, and loads.



ANTICIPATED BENEFITS

To NASA funded missions:

The primary mission for MADMACS in a Suit is to aid in the development of High Reliability Life Support Systems, for both space suits and vehicles.

MADMACS will fly on unmanned test flights of new vehicles, such as Orion. It can wear many suits during launch, landing, or EVA. MADMACS will travel to remote locations to help test the new Mars Surface Suit.

To NASA unfunded & planned missions:

The primary mission for MADMACS in a Suit is to aid in the development of High Reliability Life Support Systems, for both space suits and vehicles.

MADMACS will fly on unmanned test flights of future vehicles, such as the Asteroid Capture Concept Vehicle. MADMACS will

MADMACS Humanoid Metabolic Simulator in Integrated Multi-Sensor-Configurable Suit.

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travel to remote locations to help test the new Surface Exploration Vehicles.

To other government agencies:

The primary mission for MADMACS in a Suit is to aid in the development of High Reliability Life Support Systems.

MADMACS in a Suit will be capable of entering areas unfit for humans, and could find potential applications for OSHA, EPA, DOD, and other agencies dealing with human health and safety.

To the commercial space industry:

The primary mission for MADMACS in a Suit is to aid in the development of High Reliability Life Support Systems, for both space suits and vehicles.

MADMACS will fly on unmanned test flights of commercial crew vehicles, such as Orbital.

To the nation:

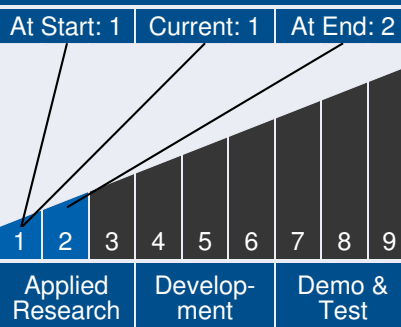
The primary mission for MADMACS in a Suit is to aid in the development of High Reliability Life Support Systems.

MADMACS in a Suit will be capable of entering areas unfit for humans, and could find potential commercial applications for first responders, chemical plant workers, and other occupations that deal with significant issues concerning human health and safety.

DETAILED DESCRIPTION

Currently, testing of High Reliability Life Support Systems for vehicles (ECLSS) and suits (PLSS) is limited to ground-based chamber tests and human-in-the-loop Vacuum Pressure Integrated Suit Testing. MADMACS in a Suit will enhance testing capabilities by flying aboard unmanned missions. MADMACS will be sized to fit a variety of suits, including those

Technology Maturity



Management Team

Program Director:

- Douglas Terrier

Program Executive:

- Douglas Terrier

Program Manager:

- Ronald Clayton

Project Manager:

- David Whitlock

Principal Investigator:

- Stuart Ross

Technology Areas

Primary Technology Area:

Human Health, Life Support & Habitation Systems (TA 6)

Secondary Technology Area:

Thermal Management Systems (TA 14)

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for launch and landing, EVA, as well as a new Mars Surface Space Suit. MADMACS will provide configurations to support state-of-the-art monitoring of temperature, humidity, launch and landing loads, and even exposure to radiation. By substituting for the human-in-the-loop, MADMACS will be able to withstand testing involving durations and/or extreme environmental conditions that are unsafe for humans. MADMACS can be equipped to support testing of both Liquid Cooling and Ventilation Garment (LCVG) enhancements and development of new Direct Blood Cooling technology. Accelerometers will allow testing of environmental loads and crew support and comfort.

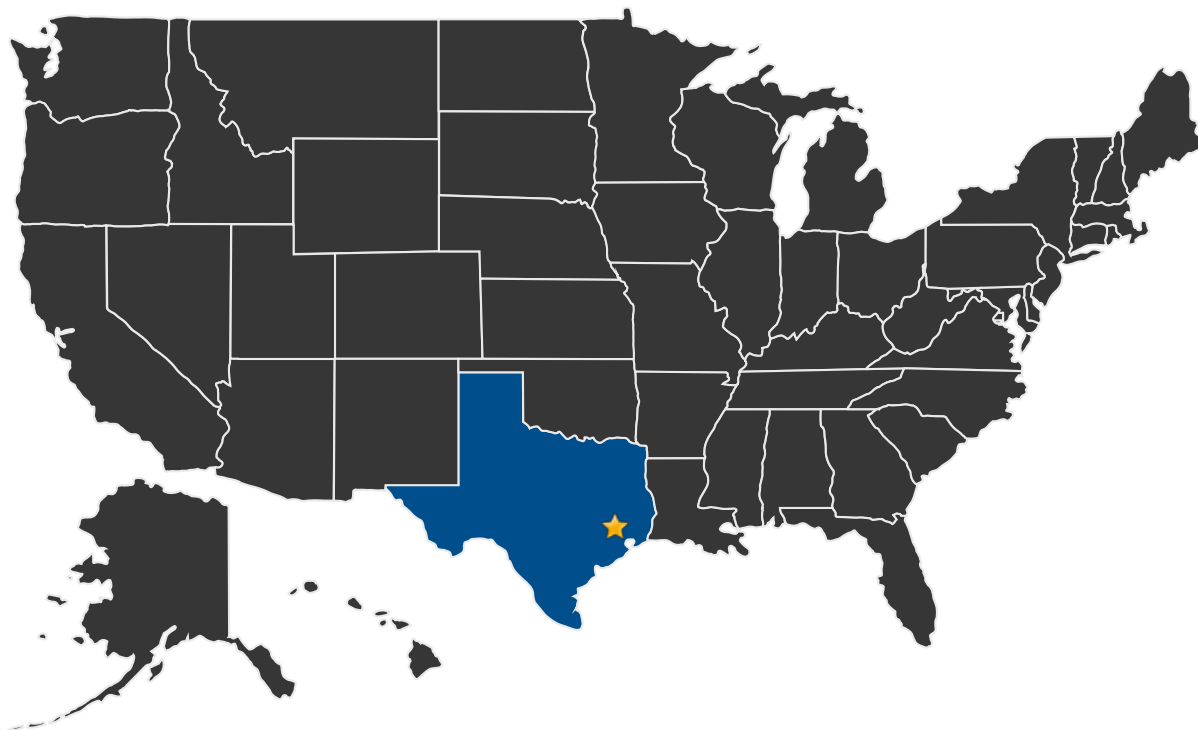
The initial stages of the investigation will focus on human factors, such as oxygen consumption, and resultant waste products generated (carbon dioxide, water vapor, heat, and other gaseous emissions). Both existing and new technologies will be considered for their ability to consume life support system provided oxygen, along with project supplied consumables, to determine which best models satisfactory metabolic rates. Appropriate monitors for temperature, humidity, pressure, radiation exposure, and acceleration will be identified, and their specifications qualified as meeting applicable requirements. A lifelike humanoid form will allow MADMACS to test other human factor conditions such as crew support furnishings.

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U.S. LOCATIONS WORKING ON THIS PROJECT



■ U.S. States With Work ★ **Lead Center:**
Johnson Space Center

DETAILS FOR TECHNOLOGY 1

Technology Title

Multi-configurable Advanced Human Support Technology (AHST) Data Collecting Human Metabolic Simulator (HMS) Adaptable Oxygen Consuming System (MADMACS) in a Suit

Technology Description

This technology is categorized as a hardware system for unmanned spaceflight

Life Support System Development Support and Test Equipment

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Capabilities Provided

Extended extreme environmental conditions and test durations than current Man-in-the-Loop testing allows.

Potential Applications

Expanded capabilities for ground (chamber) testing of advanced life support systems for vehicles and suits. Flight capable testing of advanced life support systems for vehicles and suits onboard unmanned test flights of crewed vehicles.

Performance Metrics

Metric	Unit	Quantity
Simulate metabolism of wide population	%	95